**Organic Molecule Nomenclature**

**Carbon Backbone Prefixes Alkyl Branch Names and Structures**

|  |  |
| --- | --- |
| **Number of Carbons** | **Prefix** |
| 1 | meth- |
| 2 | eth- |
| 3 | prop- |
| 4 | but- |
| 5 | pent- |
| 6 | hex- |
| 7 | hept- |
| 8 | oct- |
| 9 | non- |
| 10 | dec- |

|  |  |  |
| --- | --- | --- |
| **Number of Carbons** | **Structural Formula** | **Name** |
| 1 | CH­3― | methyl |
| 2 | CH­3­-CH­­2― | ethyl |
| 3 | CH­3-CH­2-CH­­2― | n-propyl |
| 3 | |  CH­3-CH­-CH­­2 | isopropyl |
| 4 | CH­3-CH­2-CH­2-CH­­2― | n-butyl |
| 4 | |  CH­2  |  CH­3-CH­-CH­3 | isobutyl |
| 4 | |  CH­3-CH­-CH­­2-CH­3 | s-butyl |
| 4 | |  CH­3-C­-CH­3  |  CH­3 | t-butyl |

**Nomenclature Rules**

1. Determine the longest carbon chain. Use the number of carbons to determine prefix for backbone and type of carbon bonding for suffix (*ane, ene, or yne)*
2. Number the carbon atoms in the chain starting with the end closest to the branches
   1. For alkenes & alkynes, start with end closest to double or triple bond
3. Name each branch, and identify its position on the parent chain
4. Use the following format to give the IUPAC name:

(number of location)-(branch name)(parent chain). Use lowercase letters

* 1. For alkenes & alkynes indicate the position of the start of the double or triple bond: (number of location)-(branch name)-(multiple bond location)-(parent chain)
  2. If more than one double or triple bond, use commas to separate their position number, and use prefixes *di, tri, tetra, penta, hexa,* etc. between prefix and suffix of parent chain

1. When there is more than one branch, order them alphabetically:

(number of location)-(branch name #1)- (number of location)-(branch name #2)(parent chain)

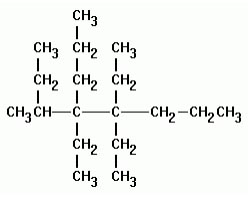
1. If the branches are the same, or more than double or triple bond, use commas to separate their position number, and use prefixes *di, tri,* etc.

Branches: (number of location), (number of location)-(prefix)(branch name)(parent chain)

# Alkanes

Simplest organic molecules as they contain only C-H single bonds. They follow the nomenclature rules.

*Name:*



3-ethylheptane 4,5,5-triethyl-4-n-propyl-3-methyloctance

*Draw:*

3-t-butyl-5-methylheptane 3-ethyl-2,2-dimethylhexane

# Alkenes/Alkynes

Naming is the same for alkanes with 3 differences.

1. The carbons in the backbone are numbered started at the end closest to the double bond not the end closest to the first branch
2. Instead of –ane, -ene is used for double bonds, and –yne for triple bonds.
3. The position of the double or triple bond is numbered. The number of the carbon it starts at is placed between backbone prefix and –ene or –yne ending
   1. If there are more than one double or triple bonds, they are numbered using commas, and a prefix, *di, tri, tetra,* etc are

*Name:* *Draw:*

2,3-dimethylpent-1-ene 4-methylpent-2-yne

# Common Names: ethene🡪ethylene, propene🡪propylene, ethyne🡪acetylene

# Aromatic

methylbenzene 1,2-dimethylbenzene 1,3-dimethylbenzene 1,4-dimethylbenzene

toluene o-dimethylbenzene m-dimethylbenzene p-dimethylbenzene

(ortho) (meta) (para)

Aromatic compounds can be named as benzenes with branches, or as chains with benzenes as branches. As branches benzenes as named –phenyl groups. It’s often best to choose which would be simpler to name. When numbering them, number them with branches having the lowest possible numbers.

*Name:*

1,4-diethyl-2-methylbenzene 4-ethyl-5-phenylhept-2-ene

# Isomers

*Structural Isomers:* Chemicals with same molecular formula, but with different structures and different names

butane C4H10  2-methylpropane C4H10

*Geometric Isomers:* Molecules that differ in structure only by the position of groups attached on either side of the molecular structure.

*Cis* *Trans*

cis-2-butene trans-2-butene

# Functional Groups

Functional group: Structural arrangement of molecules that gives specific characteristics to the molecules such as polarity, boiling point….

1. Carbon-Carbon Multiple Bonds
   1. C-C bonds are strongly covalent
   2. Pi bond are more reactive than sigma bonds so C=C bonds and C≡C bonds will have increased reactivity
      1. Benzene’s reactivity is in between alkanes and alkenes because it’s electrons are delocalized: the electrons are spread out evenly over all 6 carbons due to overlap of p-orbitals, thus making a pi electron cloud.
2. Carbon bonded to electronegative atom
   1. C-O, C-N, C-X bonds
   2. Bond now has polarity, with carbon having a partial positive charge
   3. Increased polarity = increased intermolecular forces = Higher melting and boiling points = increased solubility in polar solvents
   4. With oxygen and nitrogen, H-bonding occurs increases intermolecular forces even more
3. Carbon double-bonded to oxygen
   1. Strongly polarized because pi bonds increase electron density, giving carbon a greater partial positive charge
   2. Further increases solubility in polar solvent

**Fractional distillation:** Separation of organic molecules using differences in boiling points.

|  |  |  |
| --- | --- | --- |
| Functional Group | Name | Prefix |
| -F | fluorine | fluoro |
| -Cl | chlorine | chloro |
| -Br | bromine | bromo |
| -I | iodine | iodo |
| -OH | hydroxyl | hydroxy |
| -C=O | carbonyl | oxo |
| HO-C=O | carboxyl | carboxyl |
| -NO2 | nitro | nitro |
| -NH2 | amino | amino |

|  |  |
| --- | --- |
| **Group** | **Symbol** |
| Alkyl group | R, R’, R” etc |
| Halogen atom | X |
| Phenyl group | O |

# Alkyl Halides

* Hydrocarbons that have had at least one hydrogen atom replaced by a halogen
* Higher bp than corresponding hydrocarbons because of increased polarity
  + Now contain dipole-dipole forces

*Name*:

2,3-dichlorobutane 3-bromo-1-fluorobenzene

*Draw*:

CH3C(Br)=C(Cl)CH2CH3



# Alcohols

* Contain at least 1 hydroxyl functional group
  + Makes molecule polar
* Ability to H-bond
* Long chain alcohols have polar and non-polar sections, making alcohols good solvents
* 3 types of alcohol
  + 1°: -OH attached to carbon only attached to 1 other carbon
  + 2°: -OH attached to carbon only attached to 2 other carbons
  + 3°: -OH attached to carbon only attached to 3 other carbons
* Naming
  + Suffix “-ol” is added to end of backbone suffix
  + –OH group is numbered to carbon in chain it is attached to
* polyalcohols: multiple –OH groups
  + suffixes *diol, triol* etc added to entire chain name

Ex.

butan-1-ol (1°) butan-2-ol (2°) 2-methylpropan-2-ol (3°) propane-2,2-diol phenol

# Ethers

* R-O-R’
* Bent shaped makes molecule polar, but cannot H bond
* Having polar oxygen group and non-polar hydrocarbon chain makes ethers good solvents
* Single C-O covalent bonds difficult to break, so ethers are relatively unreactive
* Naming
* Add “-oxy” to prefix of smaller hydrocarbon, and adding that to the front of larger hydrocarbon group

*Name:*  CH3-O-CH2CH2CH3 *Draw:*  2-isopropoxypropane



1-methoxypropane

# Aldehydes & Ketones

* Both contain carbonyl C=O functional group
* aldehyde: RC(=O)H
  + Carbonyl attached to terminal carbon
  + scents, small R= strong, unpleaseant odors, large R= flower odors,
* ketone: RC(=O)R’
  + Carbonyl attached to non-terminal carbon
  + Smells travel far, good carriers of chemical signals (ex ants for food, pheromones)
* Carbonyl group is strongly polar, and has non-polar carbon chain so good solvent
  + Forces stronger in ketones because carbonyl group more centralized
  + No H bonding
* Naming
  + Aldehydes
    - Remove “*e*” from end of backbone chain and replace it with “*al*”
  + Ketones
    - Remove “*e*” from end of backbone chain and replace it with “*one*”
    - Use a number in front of the suffix to indicate which carbon the =O is attached to
* Common Names: methanol🡪formaldehyde, ethanol🡪acetaldehyde, propanone🡪acetone

*Draw:* 3-methylbutan-2-one *Name:* 3-methylbutanal

## Carboxylic Acids

* Usually sour tasting compounds ex. Sour milk, vitamin C, vinegar, active ingredient in aspirin
* Contains carboxyl functional group –COOH
  + Has both carbonyl and hydroxyl groups
* Have acidic properties because of -OH
* Polar, and can H bond with water and itself
  + Stronger forces than alcohols from increased polarity of C=O group
  + Larger molecules become more insoluble as non-polar interactions begin to dominate
* Naming
  + Remove “*e*” from backbone name and replace with “*oic*” with word “*acid*” following name
* Common names: methanoic acid 🡪 formic acid, ethanoic acid 🡪 acetic acid

*Name: Draw:*

3-ethylpentanoic acid benzoic acid

Butanoic acid

**Esters**

* Low weight acids give smells
  + perfumes
  + Naturally in plants
  + Added to processed foods as artificial flavours/scents
* Heavier are waxy solics
* General formula: RCOOR’
* Loss of –OH group = less polar
  + Less soluble in water, lower melting and boiling point than parent acids
  + Not acidic like carboxylic acids
* Naming
  + Name alkyl chain attached to oxygen using branch name as 1st word
  + Name part attached to carbonyl group as parent chain. Remove “*e*” and add ”*oate*”
* Common Names: methanoic acid🡪 formic acid, ethanoic acid🡪 acetic acid

*Name: Draw:*

ethyl benzoate methyl butanoate 3-methylbutyl ethanoate

“cherry” “apple” “banana”

**Amines**

* organic bases
* Proteins gets broken down into amines
  + What makes decomposing things smell bad
* Polar molecules because of C-N bonds and N-H bonds
* H bonding increases forces in amines
  + Not as strong as OH because NH bonds less polar
* Ammonia with hydrogens replaced by alkyl groups



Ammonia 1° amine 2° amine 3° amine

* Naming
  + Alkyl derivatives of ammonia
  + Nitro groups attached to alkane derivative
    - If there are alkyl groups attached to amino group, indicate them with “N”

*Name:*



3-aminopropane N-methyl-2-aminobutane N-ethyl-N-methyl-3-hexane

Propylamine (1°) ethyl-s-butylamine (2°) ethylmethyl-n-butylamine (3°)

**Amides**

* Amides form the backbone of all protein molecules
  + In bio they are called peptide bonds
* Have the general formula of



* Weak bases and generally insoluble in water, with small molecules being mildly soluble
* H bonding occurs when N attached to hydrogen not alkyl groups
  + Increases boiling points and melting points
* Naming
  + Similar to naming esters, except instead of “*oate”* use “*amide*” for 2nd word
  + First word is named as amines

*Name:*



N-methylethanamide N-ethyl-N-methylpropanamide N,N-dimethylmethanamide